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THE TEPARY, A NEW CULTIVATED LEGUME FROM THE SOUTHWEST

GEORGE F. FREEMAN

(WITH ELEVEN FIGURES)

The great aridity and extreme heat of the southwestern part of the United States have developed a flora singular in type and striking in contrast with such as is found in the more humid sections. So widely distinct are the atmospheric conditions that none but the hardiest and most adaptable of introduced plants are able to withstand the violent readjustment made necessary by the new environment, even though water in abundance be artificially supplied. Professor J. J. THORNBER of this station is authority for the statement that only a small percentage of plants or varieties developed in sections having a decidedly different climate from that of Arizona may be successfully cultivated here.

Alfalfa, which has been grown within the territory for many years, is now thoroughly acclimatized and is today our greatest single farm product. Among other crops introduced since the European settlement of Arizona and southern California and thoroughly acclimatized may be mentioned barley, the white Sonora wheat, the olive, pomegranate, and several varieties of figs, dates, and citrus fruits. Realizing that the plants which are most successful in resisting the vicissitudes and appropriating the peculiar advantages of the climate of Arizona are those which have been longest grown within its borders, the writer has had his attention drawn to some of the native economic plants of this region. Among these may be found varieties of agricultural plants which have been grown within the confines of Arizona for hundreds or perhaps even thousands of years, years when the ruins that now crumble in the desert sands were populated with a happy and prosperous race, years when the canal systems which still can be distinctly traced ran on higher levels and watered more lands than those which at the present time distribute the waters of the Gila and Salt rivers. Here among the Pima and Papago Indians, descendants or successors of these former builders, may be found varieties of corn, beans, pumpkins, and squashes which have survived the race under whose husbandry they were produced. Centuries of adaptation have therefore produced types eminently suited to withstand the extremes of heat and drought to which the climate and indifferent agriculture of a primitive people often exposed them.

The investigations of which this paper forms a report are concerned with the varieties of native beans only. The need for a leguminous food plant to restore nitrogen to soils irrigated with pumped water, and the necessity of finding drought-resistant crops suitable for use where "dry-farming" is being attempted, has directed the attention of the Arizona Experiment Station to these beans for several years. Tests at Yuma under irrigation, and at McNeal under dry farm conditions, have already demonstrated the ability of these native beans to fulfil all of the requirements of drought-resistance and fertilizing value, and in addition they have the ability to produce profitable crops of a staple product.

During these agricultural tests, made for the most part from seeds secured originally from the Indians, it was noticed that many apparently different sorts occurred. In order to study the different varieties in their native condition, therefore, and to secure samples for testing their relative values, the writer in company with Director FORBES spent two weeks during late July and early August 1910 among the Papago Indians in their villages situated in the valley between the Baboquivari and Quijotoa mountains, some 50–100 miles southwest of Tucson. Here, in a region with 9 inches of rainfall annually, these beans were being grown successfully with no irrigation save that of a little flood water which came down the mountain washes.

During the course of this trip 32 samples of beans were secured. In addition to these, 10 samples had been previously secured by Mr. CAVILLO from the Papago Indians near Santa Rosa and grown one year at Yuma; 7 samples were furnished by Professor J. J. THORNBER from beans secured from the Pimas at Sacaton; some 25 carefully selected samples were contributed by Mr. MENAGER, of the Indian Oasis, which he picked from beans secured from the Papagos, and finally, as a result of a three days' trip among the

Pimas at Sacaton, 16 additional samples were secured. This mass of material when carefully sorted yielded 71 apparently distinct sorts. These were planted on the testing grounds at the university during the summer of 1910 and produced strains of the most widely diverse types and economic values.

The first lot of seed coming into the hands of the writer were 10 samples obtained originally from Mr. CAVILLO at Santa Rosa, but which had been grown for one year at the Experiment Station at Yuma. In working over this material two distinct types were observed. The first type was characterized by a larger size, averaging about 0.23 gm. When present at all, the markings or flecks were much coarser; there was an absence of lines radiating from the hilum, such as are used by botanists to distinguish between the kidney and lima beans. Another distinguishing characteristic of this group was the smoother, more glistening surface of the seed coat. The second type averaged distinctly smaller (about 0.15 gm.); the markings or flecks when present were much finer; distinct lines radiating from the hilum were frequently present; the surface of the seed coat lacked the characteristic glossiness of the first type. Inquiry soon developed the fact that Indians and Mexicans of southern Arizona and Sonora distinguish sharply these two classes, the latter designating the first type as "frijoles" and the second as "teparies." It is interesting to note that they think of these two legumes as being quite as distinct as we should think of rye and wheat. After once becoming familiar with the differences between the two types, anyone recognizes without hesitation and at a glance whether any given sample is composed of teparies or frijoles, in spite of the fact that previously he may never have seen that particular variety.

Frijoles

The common frijole undoubtedly belongs to *Phaseolus vulgaris* Linn. The Papago equivalent of the bean is *mōn*. They call a certain yellow bean *sōam mōn* (*sōam*=yellow, *mōn*=bean). In like manner they call the pink bean *yura mōn*. The word *yura* is of Yaqui origin and is said to refer here to the white man rather than to the color of the bean, thus meaning "the white man bean."

This also accords with the Indian tradition that beans had been secured from the white man, but that they had grown teparies "long time." Distributional and other evidence also points to the more southern origin of beans, which in all probability were brought northward by the earlier Spanish settlers and missionaries.

Teparies

The name tepary or *tepari* (Spanish) originated from the Papago words *stäte päve; stä-te* meaning white and *päve* having reference to the kind of plant to distinguish it from the *mōn* or bean. In like manner they speak of *sōam* (yellow) *päve* and *späte mōōk* (muddy) *päve*. In addition to the very common statement, above quoted, that they (the Indians) had secured beans from the white man, but had grown *päve* a long time, several of the old men and women of the Papago tribe in widely separated villages gave the strikingly uniform answer that their forefathers got teparies from a people which had once inhabited that region (the Baboquivari and Quijotoa district of southern Arizona), and had grown these beans in the same valleys where they are now grown, but that these people went away "long ago." However, two different old women said that they remembered having gathered dark colored wild teparies during their childhood in the mountains farther south (presumably in Sonora). It is a common statement by Mexicans that the yellow tepary grows wild in Sonora and makes vines like a morning glory in the damp soil of canyons. Weight is further given to these statements and traditions concerning the local origin of these varieties by the greater resistance of teparies to extremes of climate than is possessed by beans. Adaptation through a longer series of years, or perhaps, as the present evidence seems to indicate, even domestication from the wild state in the same localities where now grown, has rendered them more hardy than the exotic beans. When the irrigating water or rains fail, teparies will frequently make a good crop when beans are a total failure. In a field of red Indian beans belonging to a Pima Indian near Sacaton in the fall of 1910, in which the crop was a total failure on account of an insufficient water supply, the writer noted a few yellow tepary plants growing as an admixture among the beans. Under conditions such

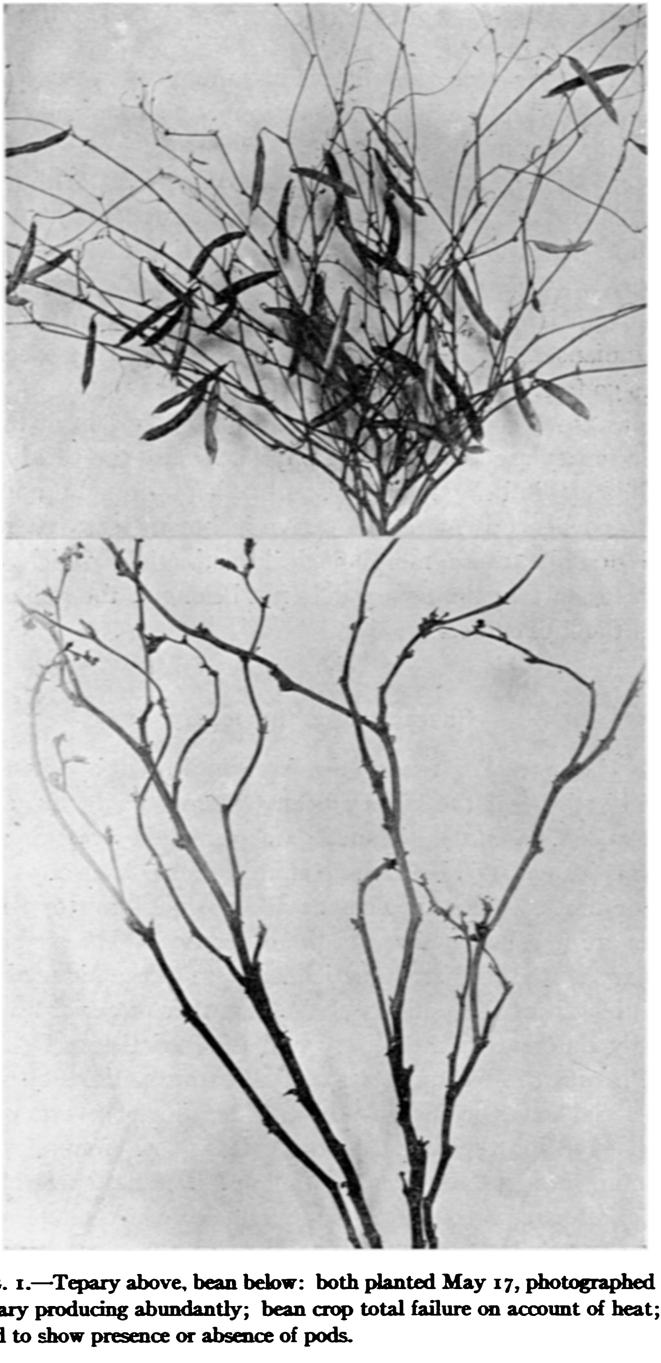

Fig. 1.—Tepary above, bean below: both planted May 17, photographed August 20; tepary producing abundantly; bean crop total failure on account of heat; leaves removed to show presence or absence of pods.

that the most vigorous of the beans had produced but two or three pods, some of the tepary plants had as many as 200 ripe pods and the average was more than 100. During 1911 pink beans which were planted May 17 had not bloomed on account of the heat as late as August 20, although they have been well irrigated during that time (fig. 1). Teparies planted alongside the beans on the same day and given identical treatment had by that time ripened an abundant crop of seed. It is a common statement among the Pima Indians that when the beans are destroyed by insects the teparies go free.

It has now been noted that the traditional origin of the bean and the tepary are distinct, that physiologically the tepary differs from the bean in being more resistant to heat, drought, and insect attack, and hence is more productive in hot regions. It remains yet to describe those morphological distinctions which compel the conclusion that the tepary does not belong to the same species as does the kidney bean.

Characters of the tepary

The characters of tepary are best indicated by contrasting them with those of the kidney bean (*Phaseolus vulgaris*) and the lima bean (*P. lunatus*). The seeds are smaller, averaging about 0.15 gm. instead of about 0.23 gm. for beans and 0.50 gm. or more for limas. When present at all, the markings or flecks on teparies are much finer than on the other two. The seed coat of the tepary lacks the characteristic glossiness of the kidney bean.

The length of the petioles of the first pair of aerial leaves are strikingly different in the tepary and the varieties of *P. vulgaris* and *P. lunatus*. Measurements of the mature petioles of the first pair of aerial leaves on a large number of seedling of several varieties of each gave for the average of the tepary 4.3 mm., for beans 24.33 mm., and for the limas 43.7 mm. The first pair of aerial leaves of all three species are simple, but those of the tepary differ from the others in having truncate instead of cordate bases (figs. 2 and 3). They are also smaller and narrower, the averages being as shown in table I.

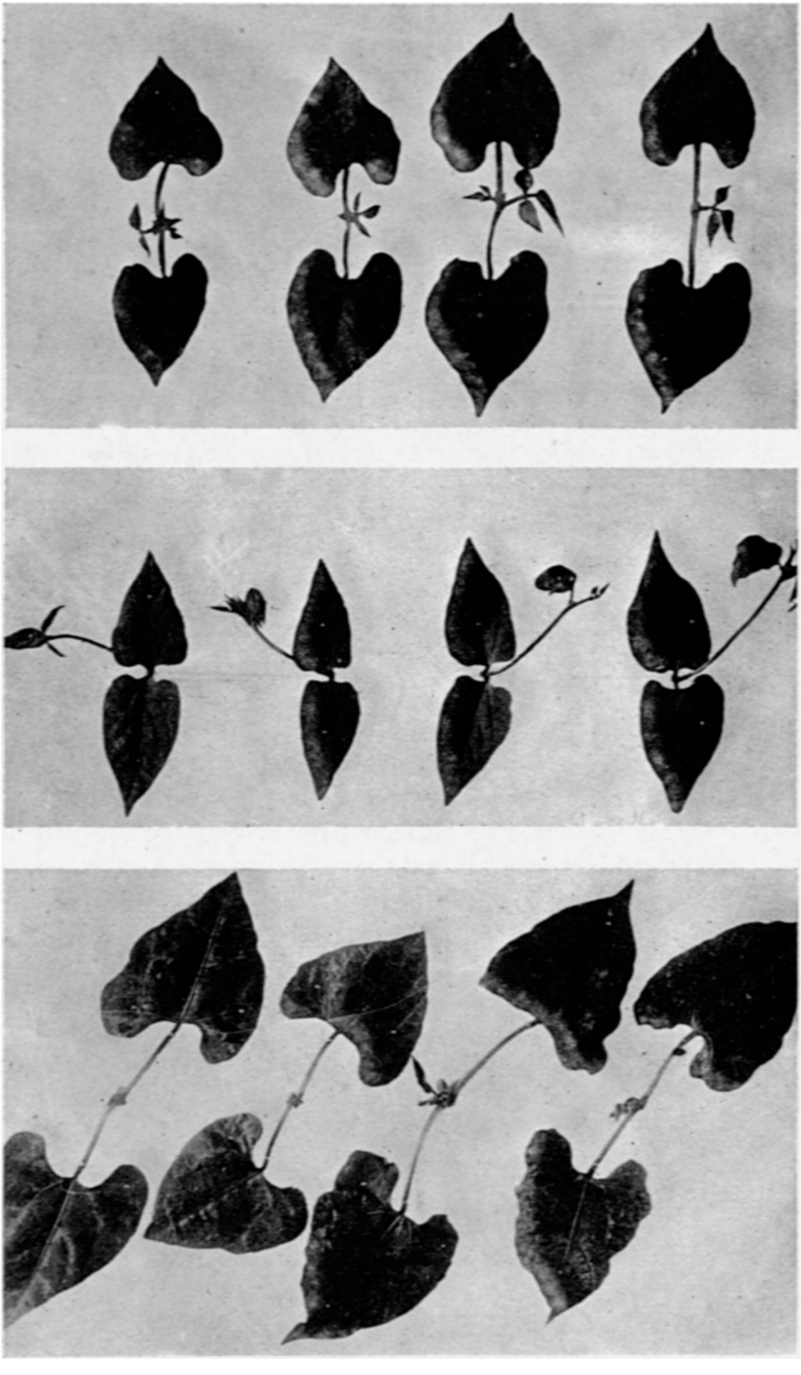

FIG. 2.—Seedlings showing first pair of aerial leaves; top, bean; middle, tepary; bottom, lima bean.

TABLE I

	Av. length mm.	Av. width mm.	Ratio $\frac{W.}{L.}$
Tepary	55.12	33.14	1.67
Kidney bean	47.32	45.86	1.01
Lima bean	72.80	66.89	1.08

The apices of all the leaves of the tepary are more acute than those of either the kidney or lima beans, and they are also much smoother (not crumpled and rough).

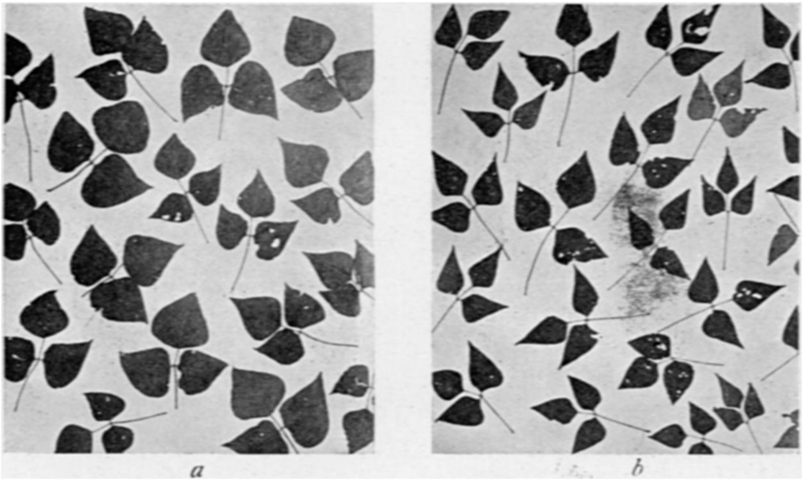

FIG. 3.—Typical leaves of bean (*a*) and tepary (*b*)

The length and breadth of the terminal leaflets of 100 normal mature leaves taken at random and including several varieties each of both beans and teparies were measured with the following results:

TABLE II

	Av. length mm.	Av. breadth mm.	Ratio $\frac{L.}{B.}$
Teparies	63.80	36.59	1.74
Beans	78.80	64.70	1.21

The flowers of the tepary are smaller than those of the bean, the wings are narrower in comparison with their length, and the banner is more strongly reflexed in flower. The calyx tube is deeper in the tepary, and the two upper teeth are united to form one prominent acuminate tooth rather than being separate and nearly obscure as in the bean. The lower three teeth of the calyx tube of the tepary are also much longer and more tapering than those of the bean, being described as acuminate rather than acute triangular to obtuse or rounded as in the latter species (fig. 4). The bracts subtending the calyx of the bean are large and nearly orbicular, measuring about 5 mm. in either direction. The corresponding bracts of the tepary are exceedingly small, inconspicuous, and early deciduous. They are lanceolate in outline and are about 1.5 mm. long by 0.5–0.66 mm. broad. In this respect the tepary resembles the lima bean. The flower of the lima differs from that of the bean or tepary in having its banner of a different texture and color from the wings, since it contains chlorophyll and is a pale greenish-yellow color with a purple tinge, whereas the banner of the other two species is either white or colored in the normal way.

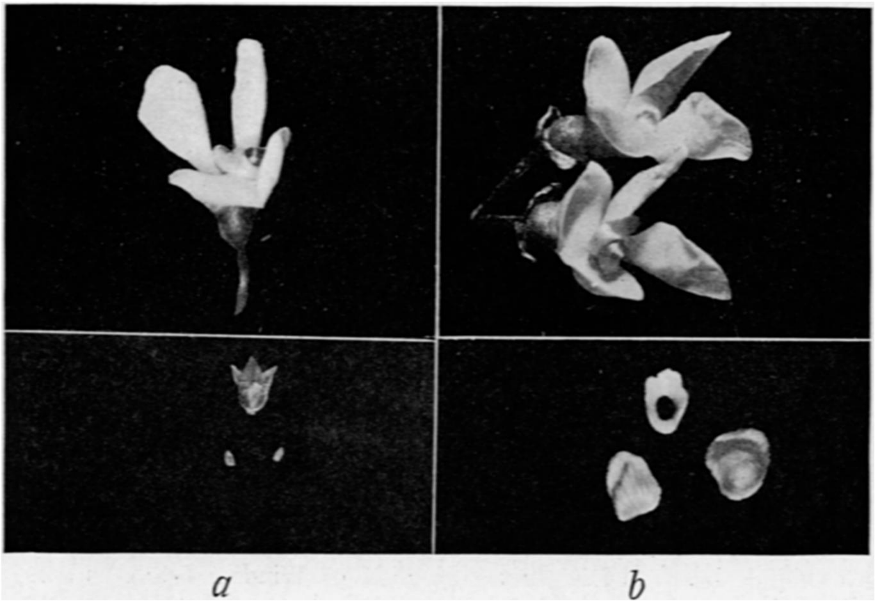

FIG. 4.—Flowers of tepary (*a*) and bean (*b*) above; dissected calyx tube and bracts of each below.

In all three species, at the opposite side of the hilum from the micropyle, the raphe ends with a more or less prominent elevation. In beans and teparies this elevation is completely divided into two lobes by a crease beginning at the hilum and passing between them. In the limas, on the other hand, the crease enters the elevation but does not pass entirely through it. The raphe of the lima therefore ends in a V-shaped, two-pronged elevation rather than in two rounded, completely separated elevations as in the other two species (fig. 5). The character generally used in botanical keys to distinguish between the lima and kidney bean is the presence of vascular lines radiating from the hilum. These are distinctly visible in the former, but lacking in the latter species. This character is very variable in the tepary, being prominent in some varieties and entirely wanting in others, with every degree of variation between these extremes.

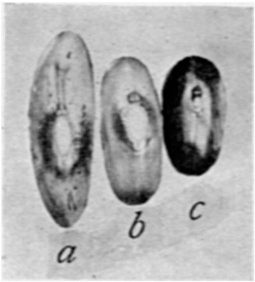

FIG. 5.—Ventral view of lima bean (*a*), bean (*b*), and tepary (*c*).

Since the tepary does not belong to either of the species which include the varieties of the kidney and lima beans, the question arises whether it has heretofore been recognized among the domesticated beans.

In the monographs of JARVIS[1] and IRISH[2] on the garden beans, five genera are recognized: *Phaseolus* (kidney bean), *Vicia* (broad, English, or Windsor beans), *Vigna* (cowpea), *Dolichos* (asparagus bean), and *Glycine* (soy, soja, or coffee bean). To these TRACY[3] adds macunna (velvet bean).

The economic species of *Phaseolus*, according to each of these writers, are three:[4] *P. vulgaris* (kidney bean), *P. lunatus* (lima bean), and *P. multiflorus* (runner bean). BAILEY[5] states that the moth bean (*P. aconitifolius* Jacq.) is cultivated as a human food in India, and that *P. Mungo* Linn., with its vars. *glaber* Roxberg (adzuki bean) and *radiatus* Hook., are widely cultivated in southern Asia. It has already been shown that the tepary differs specifically from *P. vulgaris* and *P. lunatus*. It may now be distinguished from *P. multiflorus*, *P. aconitifolius*, and *P. Mungo* by the following characters:

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[1] JARVIS, C. D., American varieties of beans. Cornell Bull. 260. pp. 149–245. 1908.

[2] IRISH. H. C., Garden beans cultivated as esculents. Missouri Bot. Gard. Ann. Rept. 12. pp. 81–165. 1909.

[3] TRACY, W. W., JR., American varieties of garden beans. U.S. Dept. Agric., Bur. Pl. Ind. Bull. 109. pp. 5–173. 1907.

[4] The seven species of common bean (*P. vulgaris* Savi, *P. compressus* Martens, *P. gonospermus* Savi, *P. carinatus* Martens, *P. oblongus* Savi, *P. ellipticus* Martens, and *P. sphaericus* Martens), which were separated by GEORGE VON MARTENS (*Die Gardenbohnen*. 1860) according to the shape and size of the seed, are now recognized as varieties of *P. vulgaris* L.

TABLE III

	Tepary	*P. multiflorus*	*P. aconitifolius*	*P. Mungo*
Leaflets..	Simple	Simple	2–3 lobed at apex	Simple
Flowers..	4–5, small, at the end of raceme which is generally inferior to the leaves	Large and showy, in many-flowered racemes	Very small, yellowish, in heads at the ends of axillary peduncles	Rather small, yellowish, in a capitate cluster of 5 or 6 on the end of stout hairy axillary peduncles
Stem....	Nearly smooth or slightly puberulent	Minutely pubescent	Brown hairy	Densely clothed with long brown hairs

Since it is evident that the tepary does not belong to any of the species now recognized as cultivated esculents or ornamentals, there remains to compare it with the described wild species. The *Index Kewensis* lists 141 species of *Phaseolus*, of which 90 are indigenous to North and South America and the adjacent islands. ROSE[6] states that "nearly 50 species of *Phaseolus* have been reported from Mexico and Central America, and I have no doubt but many remain yet undescribed." Upon going over the available literature I have been able to find 54 species recorded as growing in the southwestern United States, Mexico, and Central America. Indian tradition states that the tepary has been grown within its present habitat since prehistoric times. The physiological evidence from the hardiness and drought-resistance of these plants supports this view. It is more than likely, therefore, that this species was domesticated from wild plants growing within this region or adjacent Mexico rather than from species indigenous to moist tropical countries farther south, which were undoubtedly the original home of the less drought-resistant *P. vulgaris* and *P. lunatus.* I have been unable to secure descriptions of all of the wild species reported from Mexico and Central America, but the specific characters of the greater part of the list has been gone over very carefully.

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[5] BAILEY, L. H., Cyclopedia of Amer. hort. pp. 1294–1296. 1901.

[6] ROSE, J. N., Notes on useful plants of Mexico. Contrib. U.S. Nat. Herb. **5**:212. 1899.

Phaseolus brevicalyx Micheli (Mém. Soc. Phys. Genève **34**: 261. *pl. 12.* 1903) is a close relative of the tepary. The latter differs from this species, however, in being glabrous or only slightly puberulent, while *P. brevicalyx* is described as pilose. It further differs strongly in the following points: petioles 2–10 cm. long (average 6.8 cm.) rather than 1–3 cm., stipules lanceolate and appressed rather than broadly ovate and spreading, calyx never punctate with black spots.

The description of *P. proriferus* M. E. Jones, though very incomplete, indicates that this also is a near relative of the tepary, but it seems to differ from the tepary in being more robust and in the rhombic-ovate, abruptly acuminate leaflets.

The following description of *P. acutifolius* Gray[7] seems to agree with the tepary in every particular:

> P. ACUTIFOLIUS, sp. nov.—Volubilis; ramis gracillimis puberulis; foliolis subovato-lanceolatis e basi ad apicem usque attenuatis acutis integerrimis scabrido-puberulis; pedunculis paucifloris folio brevioribus, bracteis bracteolisque subulatis minimis deciduis; pedicellis flore aequilongis; calyce profunde bilabiato, labio superiore vix emarginato dentibus lateralibus et infimo ovato-oblongis subaequalibus tubo paulo brevioribus; legumine compresso lato-lineari falcato pubescente; seminibus complanatis leviter rugosis.—Mountain valley 30 miles east of El Paso; Sept.—Plant in general aspect and foliage much resembling a slender narrow-leaved variety of *P. helvolus;* but the leaves are more tapering and pointed; the 2–3-flowered peduncles are shorter than the leaf, and seldom longer than the common petiole; and the pedicellate flowers are smaller than those of *P perennis.* It belongs to the section DREPANOSPRON, having a flat and falcate legume, not much curved, two inches long, a quarter of an inch wide, 8–9-seeded. Seeds oval, compressed, somewhat shining, lightly rugose. The leaflets are from one to two inches long, varying from ovate-lanceolate to lanceolate from a broad base.

Specimens of the tepary have been submitted to Dr. J. N. ROSE, who states in a letter: "I quite agree with you that your Indian bean is different from *P. vulgaris*, although rather closely related to it. I would suggest that you compare it with *P. acutifolius*." In a later letter he says: "We have specimens named by Dr. GRAY which look very much indeed like your specimen." Unfortunately I have been unable to obtain authentic wild examples of *P. acutifolius*. Several plants occur in the herbarium of the university which bear this label, but they do not at all agree with GRAY'S original description. Photographs of these plants and also pressed specimens of the tepary were submitted to Dr. B. L. ROBINSON of the Gray Herbarium where the type specimen of *P. acutifolius* and several of its varieties are found. The matter was turned over to

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[7] GRAY, ASA, Plantae Wrightianae. pp. 43, 44.

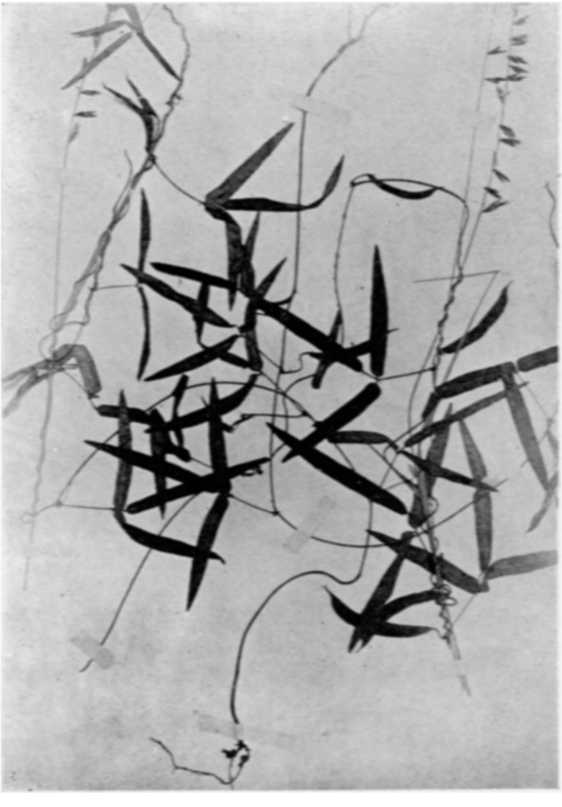

FIG. 6.—*Phaseolus acutifolius* var. *tenuifolius* A. Gray

Dr. C. A. WEATHERBY, who after careful comparison with the types left by Dr. GRAY wrote as follows:

> The type of *P. acutifolius* Gray is a plant collected by WRIGHT in western Texas in Sept. 1849. . . . . Your plant is evidently near it, differing in its much longer petiolules of the central leaflet and in its broader leaflets. The plants [referring to the photographs] with narrow leaflets are *P. acutifolius* var. *tenuifolius* Gray [fig. 6]. There is also a second variety mentioned by Dr. GRAY in the *Plantae Wrightianae* [2:33] without name, which has leaflets larger and broader than in your plant and of which I will send a tracing.

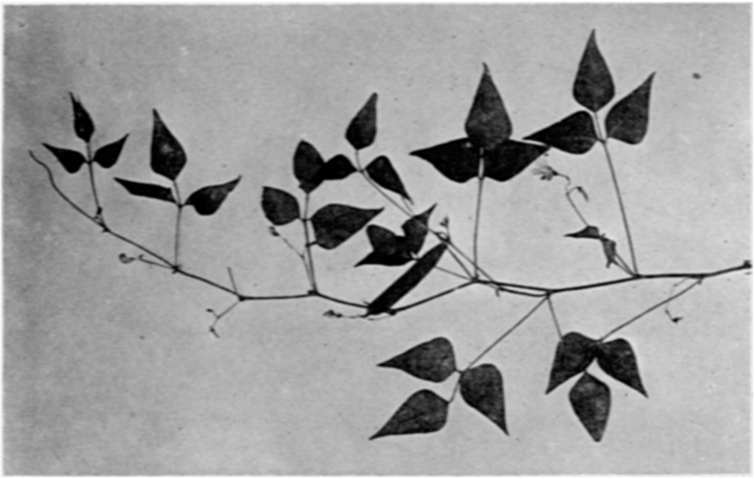

FIG. 7.—The tepary (*Phaseolus acutifolius* var. *latifolius*, n. var.)

The tracing of the type specimen of *P. acutifolius* Gray furnished by Dr. ROBINSON was found on comparison to be intermediate in form between *P. acutifolius* var. *tenuifolius* on the one extreme and the tepary on the other. The tracing of Dr. GRAY'S larger, broader-leaved, unnamed variety of *P. acutifolius*, although larger than the small specimen of the tepary which I submitted to Dr. ROBINSON, was identical with the tepary as grown upon the testing grounds at this station. In fact, this tracing might have been drawn from any one of a number of herbarium specimens of the tepary which I have made during the present season (figs. 7–9).

Careful measurements of the leaves of the specimen of *P. acutifolius* found in the National Herbarium were furnished by

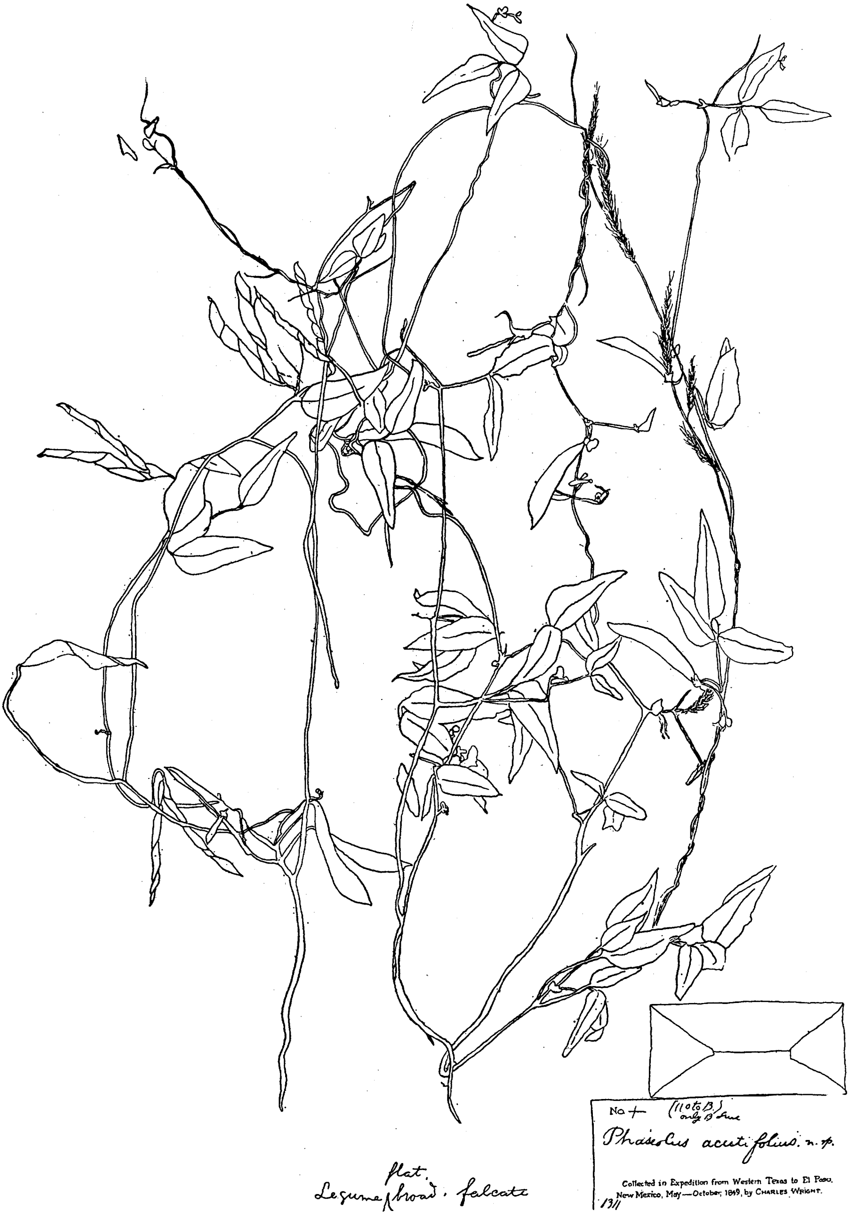
No + (11 to B.) only B true
Phaseolus acutifolius. n. sp.
Collected in Expedition from Western Texas to El Paso, New Mexico, May—October, 1849, by CHARLES WRIGHT.
1311
Legume flat, broad. falcate

FIG. 8.—*Phaseolus acutifolius* A. Gray: from tracing of the type specimen made for the writer under the direction of Dr. B. L. ROBINSON, Gray Herbarium.

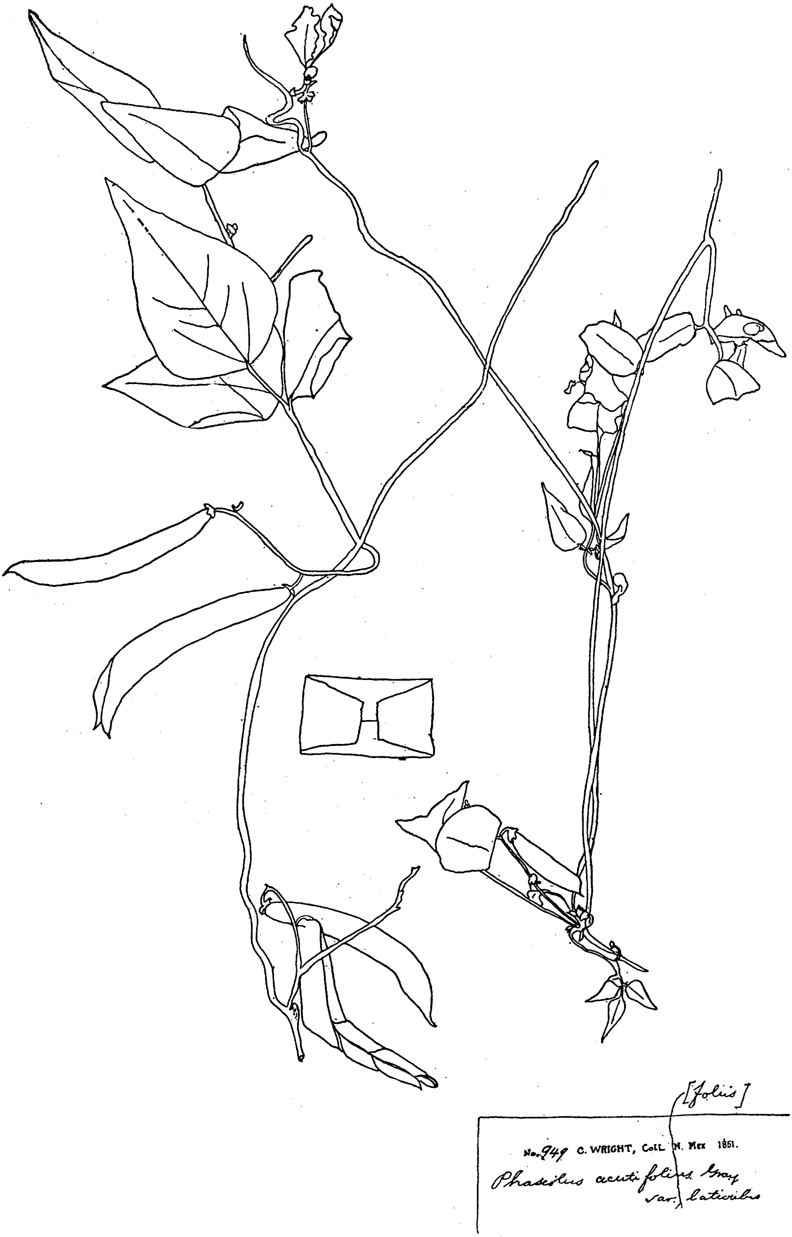
[folius]
No. 949 C. WRIGHT, Coll. N. Mex 1851.
Phaseolus acutifolius Gray
var. latiusculus

FIG. 9.—*Phaseolus acutifolius* var.: from tracing of Dr. GRAY'S unnamed variety collected by WRIGHT in a valley of Sonora; tracing made for the writer under the direction of Dr. B. L. ROBINSON, Gray Herbarium.

Professor J. J. THORNBER. In the following table these are compared with similar measurements of the tepary and the tracing of the broad-leaved variety furnished by Dr. ROBINSON. The measurements of the tepary were made from 100 mature leaves, taken at random from some 30 varietal plots during August 1911.

TABLE IV

	Phaseolus acutifolius	Tepary	GRAY'S unnamed variety
Length terminal leaflet..........	40–46 mm.	40–95 (av. 64) mm.	56–71 mm.
Width terminal leaflet..........	16–21	22–52 (av. 37)	22–41
Length lateral leaflet...........	30–42	38–78 (av. 56)	42–52
Width lateral leaflet............	12–23	20–50 (av. 33)	23–38
Length terminal petiolule.......	8–13	16–34 (av. 22)	11–18
Length petioles.................	30–40	20–100 (av. 68)	25–46

It may now be noted that the tepary leaves are decidedly larger and broader than those of the type of *P. acutifolius*, and that in the length of the petiolule of the terminal leaflet they far exceed the specific type. In most of these characters, moreover, they exceed the measurements of GRAY'S unnamed variety. It must be remembered, however, that of this latter there is but one specimen, and that upon it there is only one well matured leaf whose measurements are the maximum given. In view of the above careful comparisons but one conclusion seems possible. The tepary and GRAY'S unnamed broad-leaved variety are identical. Thus, in their broad leaves and robust growth they exhibit the opposite extreme of variation from the type of *P. acutifolius* that *P. acutifolius* var. *tenuifolius* does in the direction of narrow leaves and slender habit. GRAY'S mention of this broad-leaved variety is as follows:

> P. ACUTIFOLIUS; var. foliolis majoribus ovatis acuminatis, legumine majore (3-pollicari).—Valleys of Sonora, Sept. (949).—Plantae Wrightianae (2:33).

Although GRAY recognized it as a distinct variety, his failure to give it a name and more careful description is probably due to the fact that he had only one specimen. This lack of material I am now able to supply. I feel, therefore, that I am safe in adding to the species of *Phaseolus* which are used as esculents the name of the tepary (*P. acutifolius* A. Gray), and suggest that this variety be called *P. acutifolius* var. *latifolius*. The description is as follows:

PHASEOLUS ACUTIFOLIUS A. Gray var. **latifolius,** var. nov.—Tepary.—Annual: stems recumbent, spreading or twining, 0.5–3 m. long, glabrous to puberulent: leaves smooth above, with prominent veins beneath, glabrous throughout or slightly puberulent beneath; stipules lanceolate, 2 mm. long, 1 mm. broad, striate, appressed; petioles slender, 2–10 cm. long (av. 6.8 cm.); leaflets stipellate; terminal leaflet stalked, large, 4–9.5 cm. long (av. 6.4 cm.), 2.2–5.2 cm. wide (av. 3.7 cm.), average ratio length to width 1.74, ovate to broadly lanceolate, gradually narrowed and acute at apex; petiolule of terminal leaflets 1.6–3.4 cm. long (av. 2.2 cm.); lateral leaflets same general shape as terminal leaflet but slightly smaller and inequilateral, 3.8–7.8 cm. long (av. 5.6 cm.), 2–5 cm. broad (av. 3.3 cm.): inflorescence axillary; bracts and bractlets small, deciduous: flowers medium sized, pedicellate, white or pale violet: calyx short, 3–4 mm. long, broadly campanulate, 4-toothed (upper two lobes uniting into one), teeth acuminate, pubescence on teeth and calyx scattered and fragile: banner broad, emarginate, in flower more than half reflexed, biauriculate at base, 8–10 mm. long; wings exceeding banner, obovate to spatulate, 10–15 mm. long, auriculate on one side; keel narrow, two or three turns to the spiral: stamens in two sets (9 and 1): legume 2–7-seeded (average 4.9), 5–9 cm. long (av. 7.3 cm.), 8–13 mm. wide (av. 10.5 mm.), ciliate when young, puberulent, slightly pubescent, or smooth when mature, straight or slightly curved: seeds of different varieties white, yellow, brown, or bluish black to deep violet, either self-colored or variously flecked (no red-seeded varieties have yet been observed), round oval to nearly round (as the navy bean) to strongly flattened (like a diminutive lima).—Fig. 10.

The following table gives the averages of size and shape of the seeds as determined by measurement of at least 25 normal specimens of each of 48 different strains.

TABLE V

	Length mm.	Width mm.	Thickness mm.	Ratio $\frac{L.}{W.}$	Ratio $\frac{W.}{T.}$
Maximum varietal average . . .	9.78	6.68	4.76	1.80	2.10
Minimum varietal average. . . .	6.93	3.88	2.66	1.32	1.20
Average for all varieties.	8.56	5.68	3.80	1.49	1.51

COULTER[8] gives as the habitat of *P. acutifolius* "mountain valleys west of the Pecos, and in adjacent New Mexico and Mexico."

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[8] COULTER, J. M., Botany of western Texas. Contrib. Nat. Herb. **2**: 89. 1894.

I do not know of authentic specimens of *P. acutifolius* or its broad-leaved variety being recorded from Arizona,[9] but I have little doubt that a close search of the canyons of the southern part of the state will reveal its presence. The tepary is grown by the Indians and Spanish settlers throughout southern Arizona and northern Sonora. The further limit of its cultivation is not known to me, but it probably extends from southwest Texas, across New Mexico, Arizona, California, southward into northern Mexico.

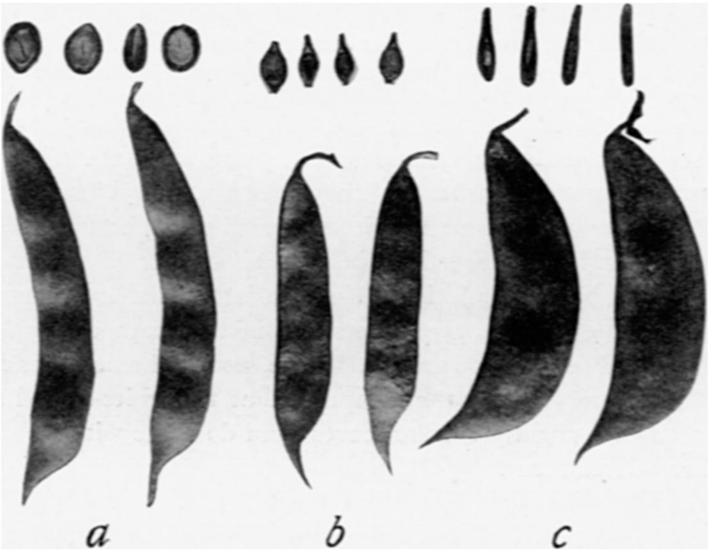

FIG. 10.—Pods of bean (*a*), tepary (*b*), and lima bean (*c*)

In order to discover whether the tepary has yet found its way into the hands of the commercial seedsmen, a list of the leading seedsmen of the country was secured. Especial attention was paid to making this list as complete as possible with regard to the seedsmen of the Southwest. Catalogues were then secured, and at least one sample of every named variety was ordered. Wherever from the description, or lack of description, there appeared a possibility that the variety in question might be closely related to the tepary, it was ordered from every available source. In this manner 216 more or less distinct varieties were secured. Nothwithstanding the fact that anyone familiar with the tepary could tell at a glance that none of these belonged to this group, all of those varieties which in any way resembled it were planted. In the seedling stage further confirmation of their relationship to *P. vulgaris* was made unnecessary by the uniformly long petioles of the first pair of aerial leaves.

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[9] It has already been mentioned that the four Arizona specimens in the herbarium of the university, which were labeled *P. acutifolius* Gray, are *P. acutifolius* var. *tenuifolius* Gray.

Varieties

Domesticated from the neighboring canyons and cultivated in small patches, attended at best by a crude husbandry, and dependent upon the precarious summer rains and uncertain floods from the mountain washes for irrigation, the tepary has lost none of its native hardiness. Like other cultivated plants, however, it has responded to domestication in the production of a number of more or less distinct varieties. These varieties manifest themselves chiefly in the color of the flowers and in the shape and color of the seed. The habit of growth, foliage, and pod characters show but little change, with the exception that the white-seeded sorts seem to have slightly smaller leaves than do those with yellow or darker colored seeds.

Food value of the tepary

There is considerable difference of opinion as to the relative palatability of beans and teparies. Among the Indians and Mexicans the pink bean is preferred to the tepary, as they say it has a better flavor. These people, however, make the same difference between the pink bean and the white navy beans which are shipped in from the East.

Teparies should be soaked 12 hours before cooking, during which time they swell to at least twice their original volume and more than double in weight. In this respect they markedly surpass the bean. The greater swelling and absorptive power of the tepary is probably due to its greater initial specific gravity, which is about 1.33 as compared with 1.22 for the bean. After soaking and cooking thoroughly, the tepary is no more dense or heavy than the bean, having overcome this in its greater expansion.

A gentleman well acquainted with the customs of the Mexican and Indian users of the teparies states that these legumes are preferred to the bean and are highly prized for the preparation of light soups. At first I thought this might be due to the extraction of less solid matter, resulting in a thinner, more delicate soup. An experiment, however, was carried out whereby an equal dry weight of beans and teparies were boiled until well done. The liquors were then made up to equal volumes, well shaken, and 100 cc. of each evaporated to dryness. Contrary to expectation, the dry residue was greater for the teparies than for the beans. The residue from the teparies was much clearer, more gelatinous, and dried into a translucent, horny flake; whereas that from the beans was more friable, and dried into a somewhat brittle mass.

Under the husbandry of the Indians, this group has shown great variation. I have been able to segregate and grow more than 40 distinct agricultural varieties and I do not doubt that many more exist which I have not yet secured. In productivity, especially where the conditions are adverse, the tepary far exceeds the bean. In 9 experiments covering three years' work at Yuma, two at Tucson, and three at McNeal, the average yield of the tepary varieties has been slightly in excess of four times the average for the varieties of the kidney bean. The explanation of these greater yields on the part of the teparies, in all probability, lies in the perfect physiological adaptation of these native plants to the climatological environment in which they had their development both as wild and domesticated species. As examples of this perfect adaptation may be mentioned the following:

a) Ability to germinate quickly in the presence of a low moisture content of the soil. This enables them to take advantage of the sudden desert downpours which wet the ground and then rapidly disappear by evaporation. Teparies, which are able to germinate and come up in 3–5 days' less time than the bean, are thus able to get their leaves into the air and their roots into the soil by the aid of showers which would be wholly inadequate for securing a stand of a less specialized crop.

When tepary seeds are placed in moist soil and the soil is pressed snugly about them, they will take up enough moisture to cause the skins to wrinkle within 5 minutes. When thrown in water, they will wrinkle within 3 minutes to a condition such as is assumed by the skin of the kidney bean only after 3–6 hours of soaking (fig. 11).

b) When once the tepary has established itself in the soil, it is able to withstand protracted seasons of water famine without permanent injury. The ability to recover from the effects of drought is not possessed by beans to a marked degree. This places them at a great disadvantage in a competition with the tepary under such conditions as are frequently met in the practice of dry farming.

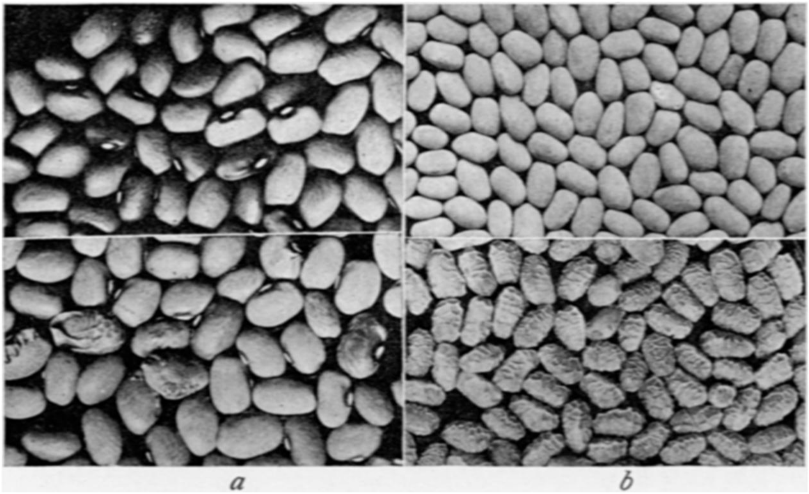

Fig. 11.—Above, beans dry (*a*) and teparies dry (*b*); below, beans after soaking in water 45 minutes (*a*) and teparies after soaking in water 3 minutes (*b*).

c) The tepary is inured to the greatest extremes of our summer temperatures and will bloom and set seed during any month from May to November. On the other hand, when the blooming period of beans happens to fall within the season of extreme heat, the buds will for the most part either abort before blooming or else the flowers will fall without setting pods. For these reasons the tepary is a more sure and dependable crop, often giving fair returns when beans are a total failure (fig. 1). As a dry land crop in the south-central plains and Rocky Mountain regions the tepary will in the near future in all probability find a place of considerable economic importance.

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